Canceled Project (2013 - 2015)

Exploration Augmentation Module Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

Conceptual Model of the Exploration Augmentation Module (EAM)

ABSTRACT

The Exploration Augmentation Module (EAM) project goal is to design and deliver a flight module that is to be deployed to Earth-Lunar Distant Retrograde Orbit (DRO). The EAM Project will, as a minimum, define, mature, and plan an implementation approach that will develop a 30-60 day crew habitat capability, airlock, and advanced EVA capabilities, and support deep space research that addresses these varied environmental and mission needs. This project was canceled for budgetary reasons.

ANTICIPATED BENEFITS

To NASA funded missions:

An EAM system is a technically greater challenge than ISS in the areas of logistics, radiation, communications, autonomous systems, storage & disposal, and volume utilization. Advancing the state-of-the-art to meet EAM project objectives will make available enhancing technologies for ISS as well.

To NASA unfunded & planned missions:

An EAM system could be enhanced to enable other NASA unfunded and planned missions, such as the Asteroid Redirect Mission (ARM), by providing an asset that would improve performance for these missions.

To the commercial space industry:

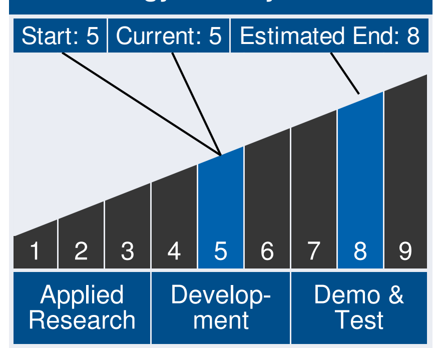
The development of EAM systems technologies in cis-lunar space offers an incremental extension of the business opportunities for commercial space at ISS -- especially with respect to commercial cargo.

To the nation:

The development of EAM systems technologies in cis-lunar space offers the next step in human exploration into the solar system and provides additional capabilities for scientific discovery.

Table of Contents

Technology Maturity



DETAILED DESCRIPTION

The EAM project goal is to design and deliver a flight module that is to be deployed to Earth-Lunar Distant Retrograde Orbit (DRO). At this location it will perform several functions: 1) perform deep-space research and exploration systems testing, 2) dock with the Asteroid Redirect Vehicle (ARV) and enable 30-to-60-day crewed asteroid utilization missions, and 3) serve as a deep space port for future deep space missions. The EAM may be launched first to ISS or to lunar DRO as early as FY2020 to support research needed for future deep space missions as well as to extend crew size, exploration functions and mission durations for the asteroid redirect mission. Acting as a deep space port, the EAM may be mated with an additional pressurized habitation module as early as the year 2028, as an augmentation for conducting possible longer duration missions in Earth-Lunar space or to Mars. Therefore, the EAM Project will, as a minimum, define, mature, and plan an implementation approach by the end of FY2014 that will develop a 30-60-crew habitat capability, airlock, and advanced EVA capabilities, and support deep space research that addresses these varied environmental and mission needs.

The EAM project end product will possibly include the delivery of the EAM protoflight module for launch in the FY2019 time frame, as well as the flight planning and hardware to accommodate the progressive in-orbit build-up and modifications that will support the exploration capability demonstrations (possibly on ISS), the 30-to-60-day Asteroid Utilization Missions, and the augmented long-duration deep space configurations to support either extended Earth-Lunar missions or deep space excursions such as missions to Mars. The EAM configuration is still under assessment. The major functions of the EAM are to provide habitation for 30-60 days for a crew of four in deep space docked with the Orion spacecraft; provide EVA capability; provide capability for testing exploration systems (Environmental Controll and Life Support Systems, long duration food storage, radiation mitigation, teleoperations of robotic systems,

Realized Benefits

6 Conference Papers
4 Publications

Management Team

Program Director:
- Jason Crusan

Program Executive:
- Douglas Craig

Project Manager:
- Lora Bailey

Principal Investigator:
- Lora Bailey

Technology Areas

Primary Technology Area:
Human Health, Life Support, and Habitation Systems (TA 6)
└ Environmental Control and Life Support Systems and Habitation Systems (TA 6.1)
  └ Habitation (TA 6.1.4)
    └ Lightweight Crew Quarters (TA 6.1.4.7)

Continued on following page.

spacecraft autonomy, etc.) in deep space; provide for exploration of redirected asteroid into DRO, including sample curation and emplacement of instrument;, and to provide a first foothold in deep space for future exploration missions including docking ports for visiting vehicles.

NASA's Advanced Exploration Systems (AES) is pioneering new approaches for rapidly developing prototype systems, demonstrating key capabilities, and validating operational concepts for future human missions beyond Earth orbit. AES activities are uniquely related to crew safety and mission operations in deep space, and are strongly coupled to future vehicle development. Early integration and testing of prototype systems reduces risk and improves affordability of exploration mission elements. The prototype systems developed in AES are to be demonstrated in ground-based test-beds, field tests, and in-flight experiments. In addition to developing building blocks for future missions, AES explores innovative ways to drive a rapid pace of progress, streamline project management, and use limited resources and the NASA workforce more effectively.

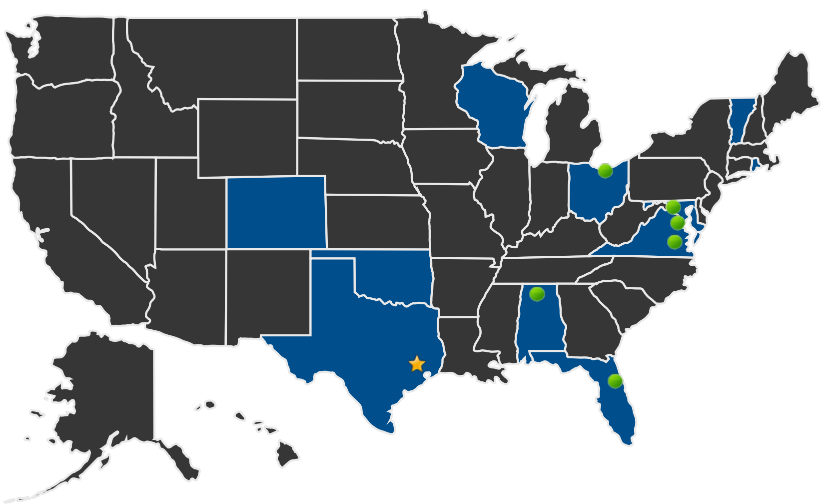
For its education and public outreach goal, the EAM project directly contributes to the development of the sciences, technologies, engineering and math (STEM) workforce in disciplines needed to achieve NASA's strategic goals. The eXploration Habitat (X-Hab) academic innovation challenge is a university-level challenge designed to engage and retain students in STEM, as well as to train and develop the STEM workforce of the future needed to implement U.S. space exploration policy.

Technology Areas *(cont.)*

- Human Health, Life Support, and Habitation Systems (TA 6)
  - Human Health and Performance (TA 6.3)
    - Human Factors (TA 6.3.4)
      - Advanced User Interface Concepts (TA 6.3.4.1)
      - Long-Duration Microgravity Workstation and Habitat Tools (TA 6.3.4.5)
      - Human-Systems Interfaces for Increased Autonomy and New Environments (TA 6.3.4.6)
      - Human-Robotic Interfaces for Increased Autonomy (TA 6.3.4.7)
      - Ergonomics of Crew Hardware Interface (TA 6.3.4.8)
  - Environmental Monitoring, Safety, and Emergency Response (TA 6.4)
    - Sensors: Air, Water, Microbial, and Acoustic (TA 6.4.1)
      - Major Constituents Sensor (TA 6.4.1.2)
    - Fire: Detection, Suppression, and Recovery (TA 6.4.2)
      - Cabin Fire: Detection System (TA 6.4.2.2)

Continued on following page.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Johnson Space Center

Supporting Centers:

- Glenn Research Center
- Goddard Space Flight Center
- Kennedy Space Center
- Langley Research Center
- Marshall Space Flight Center
- NASA Headquarters

Other Organizations Performing Work:

- Jacobs Engineering
- Oklahoma State University (Stillwater, OK)
- University of Colorado at Boulder (Boulder, CO)
- University of South Alabama
- University of Vermont
- University of Wisconsin

Technology Areas *(cont.)*

Human Exploration Destination Systems (TA 7)
- Human Mobility Systems (TA 7.3)
  - EVA Mobility (TA 7.3.1)
    - Suitport (TA 7.3.1.2)
    - Advanced Airlock/Suitlock (TA 7.3.1.6)
- Habitat Systems (TA 7.4)
  - Habitat Evolution (TA 7.4.2)
    - Exploration Habitat Systems Concurrent Engineering Modeling and Simulation (TA 7.4.2.1)
  - "Smart" Habitats (TA 7.4.3)
    - Auto-Lighting Control (TA 7.4.3.1)
- Cross-Cutting Systems (TA 7.6)
  - Construction and Assembly (TA 7.6.2)
    - Ballistic Fabric Barriers (TA 7.6.2.2)

Continued on following page.

Contributing Partners:

- NAVSEA

PROJECT LIBRARY

Conference Papers

- A Novel Approach for Engaging Academia in Collaborative Projects with NASA through the X-Hab Academic Innovation Challenge
  - (https://www.aiaa.org/meetingpapers/)
- Development of a Water Recovery System Resource Tracking Model
  - (http://arc.aiaa.org/series/6.ices)
- Habitat Concepts for Deep Space Exploration
  - (https://www.aiaa.org/meetingpapers/)
- NASA Habitat Demonstration Unit (HDU) Deep Space Habitat Analog
  - (https://www.aiaa.org/meetingpapers/)
- SLS-Derived Lab: Precursor to Deep Space Human Exploration
  - (https://www.aiaa.org/meetingpapers/)
- Space Launch System Co-Manifested Payload Options for Habitation
  - (https://www.aiaa.org/meetingpapers/)

Publications

- Design, Fabrication and Testing of a Smart Rail Prototype for the Deep Space Habitat Demonstrator
  - (http://ntrs.nasa.gov/search.jsp)
- Design, Fabrication, and Testing of a Composite Rack Prototype in support of the Deep Space Habitat Program
  - (http://ntrs.nasa.gov/search.jsp)

Continued on following page.

Technology Areas *(cont.)*

Materials, Structures, Mechanical Systems and Manufacturing (TA 12)
- Structures (TA 12.2)
  - Lightweight Concepts (TA 12.2.1)
    - Composite and Inflatable Habitat (TA 12.2.1.3)
  - Innovative, Multifunctional Concepts (TA 12.2.5)
    - Multifunctional Pressurized Structure (TA 12.2.5.2)

Publications *(cont.)*

- Engineering Polymer Blends for Impact Damage Mitigation
    - (http://ntrs.nasa.gov/search.jsp)
- Overview of Evolved Structural Prototypes in support of the Deep Space Habitat with Material and Sensor Strands Development
    - (http://ntrs.nasa.gov/search.jsp)

DETAILS FOR TECHNOLOGY 1

Technology Title

Exploration Augmentation Module

Technology Description

This technology is categorized as a hardware system for manned spaceflight

The EAM project will augment the Orion ECLSS capabilities to enable human deep space missions beyond Orion's current 21-day duration limit. Targeted duration capability is up to 60 days for a crewed mission. If berthed at ISS, the EAM will be used to advance regenerative ECLSS capabilities for deep space missions with minimal impact to ISS resources (water, O_2, N_2, etc.). Beginning in FY2014, efforts will be initiated to leverage the Multi-Purpose Crew Vehicle (MPCV)/Orion docking hatch design and incorporate commonality of the MPCV/Orion hatch into the EAM pressurized docking ports, with focus on the hatch latch/mechanisms and seal. Interface definition and integration with the docking hatch of the MPCV/Orion will advance the design and a resulting mock-up will be built for evaluation. Beginning with the current MPCV/Orion concept for the docking port hatch, further design development will be performed in an effort to promote the use of a common hatch for both the MPCV/Orion and EAM.

Capabilities Provided

The EAM project will develop a flexible integrated systems' simulation capability designed to facilitate internal reconfiguration in order to have the agility to reflect an evolving set of mission requirements, potential habitat structures, and capabilities. The EAM project will update its software-based logical models of habitat systems, leading to a robust habitat simulation that supports subsystems, operational analyses, and trade studies. The EAM project plans to first demonstrate this capability and then continue to develop it in order to support planned iterative maturation activities as well as assessments of potential partnership leveraging activities.

Potential Applications

The EAM project will integrate habitat-related technologies such as life support systems, thermal management systems, modular power systems, and software tools for autonomous mission operations, etc., into representative crew module designs for flight to meet the wide-range of possible EAM missions. Integration is to begin with mockups and logic models and progress in future years to flight hardware and certification for flight.

Other potential applications for EAM include: 1) deep-space research and exploration-systems testing, 2) docking with the Asteroid Redirect Vehicle (ARV) and enabling of 30-to-60-day crewed asteroid utilization missions, and 3) serve as a deep space port for future deep space missions. The EAM can serve as the crew-inhabited element of Earth-Moon and deep space exploration concepts. The EAM will be developed as a flexible integrated systems' simulation capability designed to facilitate internal reconfiguration in order to have the agility to reflect an evolving set of mission requirements, potential habitat structures, and capabilities.